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UNITED STATES DISTRICT COURT

CENTRAL DISTRICT OF CALIFORNIA

SEOUL SEMICONDUCTOR CO., LTD., a Korean corporation, SEOUL VIOSYS CO., LTD., a Korean corporation,

Plaintiffs,

v.

BED BATH & BEYOND, INC., a New Jersey corporation,

Defendant.

Case No. 2:18-cv-03837-SJO-SK

SECOND DECLARATION OF PROFESSOR STEVEN DENBAARS IN SUPPORT OF PLAINTIFF'S SUPPLEMENT CLAIM CONSTRUCTION BRIEF

Complaint Filed: May 8, 2018

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SECOND DECLARATION OF PROFESSOR STEVEN DENBAARS

I, Professor Steven DenBaars, hereby declare the following:

1. I am the same Professor Steven DenBaars who previously submitted a declaration in this matter and incorporate that previous declaration herein by reference.

2. I understand that the Court has indicated that it requires further information regarding the plain and ordinary meaning of the terms "quantum dot"; "transparent electrode layer"; "rectifying bridge unit"; and "multi-quantum well structure."

3. I have been asked to provide my opinion on two of those terms: "quantum dot" and "multi-quantum well structure."

Quantum Dot

4. The 1999 article from National Renewable Energy Laboratory (Eisenberg Decl. Ex. 5) and the 2000 article in the Journal of Physical Chemistry B (Eisenberg Decl. Ex. 6), in my opinion, both provide similar and related explanations of how a person of ordinary skill in the art would have understood quantum dots during the time period at issue here.

5. In particular, a "bulk" crystal material is one that exists on the ordinary size scale that people are able to interact with. As a scientist, we would say that the properties of bulk materials are independent of their size. In other words, cutting a crystalline object in half would be understood to result in two crystals half the size of the original, but having all the same observable properties (hardness, density, solubility, transparency, etc.) as the original.

6. Scientists have long understood, however, that the process of cutting a crystal in half can't continue forever. Eventually the cutting would proceed to the atomic-scale, where properties are very different from the bulk properties that we see every day.

7. As the above articles recognized, quantum wells, quantum wires, and quantum dots exist on a size scale between bulk materials and the atomic scale. That

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size scale is often referred to as nanoscale (short for nanometer-scale) or mesoscopic. The properties of nanoscale structures differ from what is seen at both bulk and atomic scale, with the properties being closely tied to the size of the structures.

8. The key to producing quantum wells, quantum wires, and quantum dots is to reduce one, two, or three dimensions of a semiconductor crystal down into the nanoscale domain. At that scale, we find that the material properties are very different from the bulk properties of the same material.

9. Around the year 2000, scientists were working to both create and model the properties of nanoscale structures. The distinction between achieving real-world results on the one hand and trying to predict or explain properties would have been understood as the difference between the work of experimental scientists (experimentalists) and theoretical scientists (theoreticians). The former work, for example, to create new materials, whereas the latter work, for example, to predict and explain the properties of those new materials.

10. With respect to quantum dots in particular, around the year 2000 both experimental scientists and theoretical scientists were hard at work in their relevant domains.

11. At that time, the experimentalists were working on methods for reproducibly creating nanoscale quantum dots from either a top down or bottom up approach. In a top down approach, the process would begin with a larger crystal, with the goal being to cut (for example lithography using a focused electron beam) the size of the crystal down to nanoscale dimensions. The bottom up approach, in contrast, would start with raw materials (usually liquids or gases) to try to build up to a nanoscale structure. For both the top-down and bottom-up approaches, the focus was on the constituent material (*i.e.*, the semiconductor crystal) and the size that could be achieved.

12. The ’731 patent is an example of the bottom-up approach to quantum dot creation. In particular, in crystal growth, the goal is usually to minimize the effects of

lattice mismatch between a substrate and a material being grown on the substrate. Lattice mismatch generally results in defects that harm the operation of the resulting crystal layer. Rather than minimize lattice mismatch, the '731 patent seeks to use that property to cause the self-assembly of quantum dots. The focus of the '731 patent, therefore, was on a method of creating semiconductor crystal structures.

13. In other words, in my opinion, the work described in the '731 patent falls within the scope of experimental studies of creating nanoscale semiconductor structures, where the focus was on the materials and the size that could be achieved. That would have been how a person having ordinary skill in the art would have understood the concept of a quantum dot based on his or her knowledge in view of the description in the '731 patent.

<u>Transparent Electrode Layer</u>

14. As is obvious from viewing the shiny surface of most metals, strong conductors generally block rather than transmit light. Gold, copper, silver, platinum, and aluminum are all examples of strong conductors that unless provided as an extremely thin layer will effectively block all light from passing through.

15. In the field of light emitting diodes, people of ordinary skill in the art are concerned with providing strong electrical connections to the device, but without blocking too much of the light that would otherwise be emitted.

16. In this context, a transparent electrode layer would have been understood as a thickness of conductive material that is capable of providing an electric current while still permitting light to pass through.

17. The prototypical transparent electrode layer in the light-emitting-diode field is indium tin oxide (ITO). A thin layer of ITO is essentially a colorless and clear material that is capable of providing a strong electrical connection to the device while permitting a substantial amount of the generated light to pass through.

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Rectifying Bridge Unit

18. A rectifying bridge unit, which can also be referred to as a bridge rectifier, is a well-known discrete electronic device.

19. The basic function of rectifiers is to take an alternating current as an input and provide unidirectional current as an output. More specifically, alternating current can be understood as a sine-like pattern, with a first half-cycle comprising a current of electrons moving in the forward direction and then a second half-cycle comprising a current of electrons moving in the reverse direction. A rectifier takes that reversing current as an input and passes only unidirectional current as an output.

20. In one simple form of rectification known as half-wave rectification, a device is used that permits current to flow in one direction and blocks all current from traveling in the reverse direction. The result is a signal comprising discrete half-waves of either forward or reverse current.

21. The textbook Electronics A Survey of Engineering Principles (Dkt. 62-13 at 5-6) provides a simple but accurate description of the operation of a bridge rectifier, which is a type of full-wave rectifier. As shown in figure 7.35, during the positive half-cycles of the alternating current, the flow of electrons are permitted to pass in the positive direction through the resister R, which comprises the structure being driven by the rectifier. In figure 7.36, the negative half-cycles of the alternating current are inverted by reversing the connection to the resister R, so that the electrons still pass in the positive direction through the resister.

22. In this way, both half-cycles of the incoming alternating current are used to drive current through the resister R in the forward direction.

Multi-Quantum Well Structure

23. In the field of light emitting diodes, a quantum well is an example of the light generating (*i.e.*, active) layer. As I explained above with respect to quantum dots, the concept of a quantum well is based on confinement, which refers to providing wider bandgap barriers around a lower bandgap structure.

24. For a single quantum well device, the well itself is a thin layer of lower bandgap material with layers of higher bandgap barriers located above and below. Nanostructures and Nanomaterials (Eisenberg Decl. Ex. 25) are a well-known text that provides an apt description of both single-quantum well and multi-quantum well devices. The difference between the two types of devices are that rather than having a single thin layer of lower bandgap material as a well, a multi-quantum well, is a stack of layers containing multiple lower bandgap wells interleaved between higher bandgap barriers.

I declare under penalty of perjury and under the laws of the United States that the foregoing is true and correct.

Date: July 11, 2019

Prof. Steven DenBaars

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